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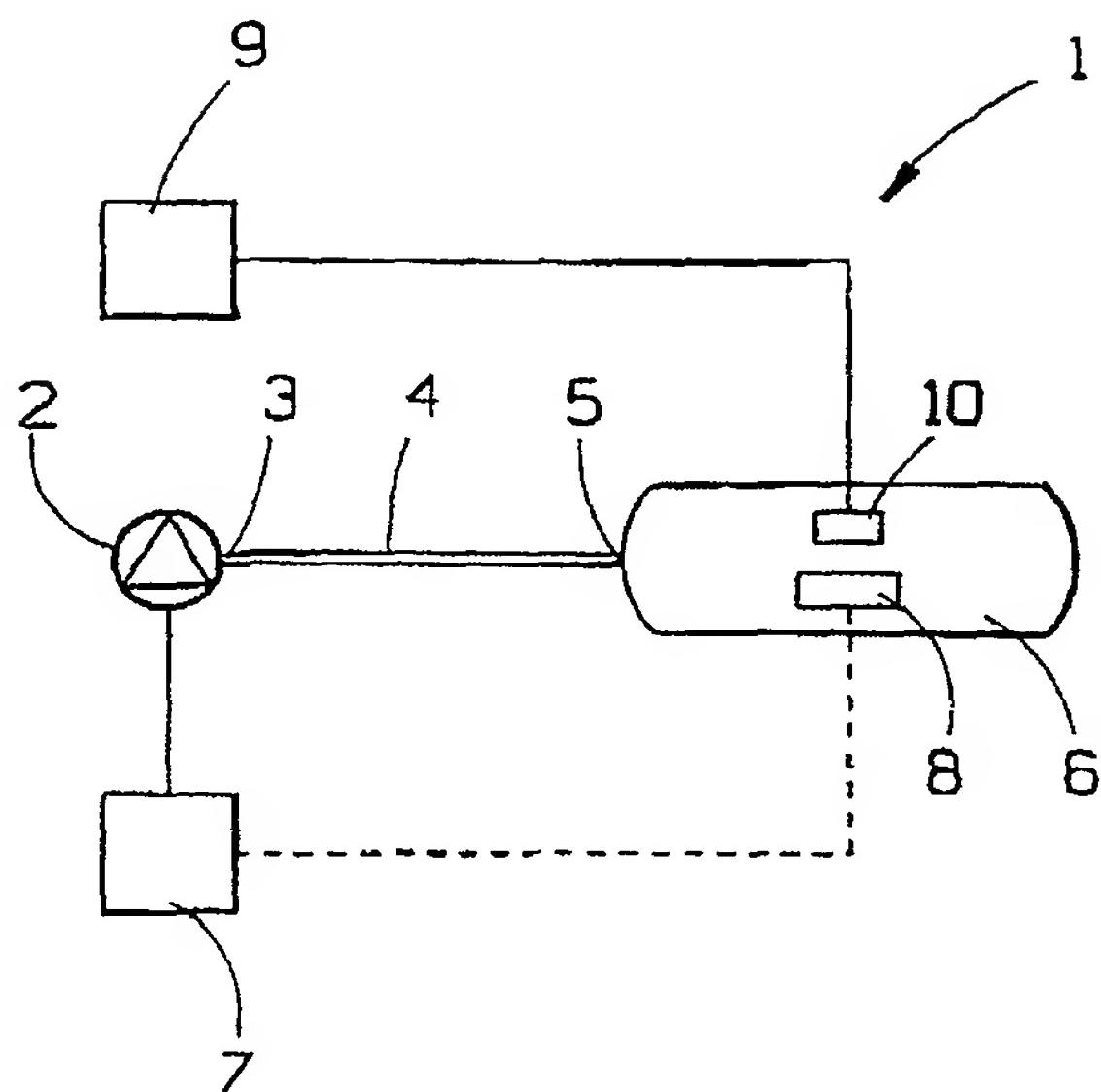
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: SYSTEM FOR SUPPLY OF A PRESSURISED GAS AND METHOD FOR VERIFYING THAT A COMPRESSOR IS ACTIVE IN A SYSTEM FOR SUPPLY OF A PRESSURISED GAS



(57) Abstract: System for supply of compressed gas, comprising one or more pressure tanks (6), a compressor (2) which can be controlled via first control member (7) and is arranged to supply said pressure tank or pressure tanks (6) with compressed gas, where said first control member (7) is arranged to adopt an active position when the compressor (2) is controlled to operate, whereby compressed gas is delivered to said pressure tanks, and a passive position when the compressor (2) is controlled not to operate.

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TITLE

System for supply of a pressurised gas and method for verifying that a compressor is active in a system for supply of a pressurised gas.

5

TECHNICAL FIELD

The present invention relates to a system for supply of compressed gas according to the preamble of Patent Claim 1, and to a method for verifying 10 whether a compressor is operating in a system for supply of compressed gas according to the preamble of Patent Claim 5.

PRIOR ART

15 Systems for supply of compressed gas generally comprise a compressor, compressed-air lines and one or more compressed-air tanks which are fed by the compressor. The compressor is usually controlled by a first control member which is arranged to set the compressor to a first, active state when the compressor is operating, i.e. feeding compressed gas to the 20 compressed-air tanks, and to a second, passive state when the compressor is not operating. In known designs, for example as shown in US 4 863 355, the first control member is connected to a pressure sensor connected to said tanks, the first control member setting the compressor to an active or inactive state depending on the pressure measured by the pressure sensor.

25

The prior art thus includes systems for controlling a compressor in a system for supply of compressed gas. Such systems lack the possibility of verifying whether or not the compressor is actually supplying the compressed-air tanks in the system. This means that knowledge of whether the compressor 30 is or is not in working order cannot be gained from the control system since it only sends a signal on activation to the compressor and thereafter ignores

whether compressed gas is being delivered to the pressure tanks or not.

BRIEF DISCLOSURE OF THE INVENTION

5 The object of the invention is to make available a system for supply of compressed gas in which it is possible to verify whether a compressor is delivering or is not delivering compressed gas to pressure tanks included in the system. This object is achieved by means of a system for supply of compressed air according to the characterizing clause of Patent Claim 1. By
10 virtue of the fact that the system comprises a second control member which is connected in signalling terms to a pressure sensor arranged in said pressure tanks and that said second control member is arranged to establish that the compressor is operating via the pressure recorded by the pressure sensor and the changes in pressure in the pressure tank, it is possible to
15 verify whether compressed gas is being delivered to the pressure tanks. According to a preferred embodiment, this knowledge can be used to control a system for cooling of compressed air. According to a second embodiment, this knowledge can also be used to provide information on whether the compressor is in working order, by comparing control instructions from the
20 first control member and the second control member, with function errors being found when the first control member indicates that the compressor is active and the second control member indicates that the compressor is passive, or vice versa. According to a third embodiment, this knowledge can also be used as information for preventive maintenance for replacing
25 desiccant cartridges in air driers and/or replacing compressors.

Said objects are achieved also by a method according to the characterizing clause of Patent Claim 5.

30 DESCRIPTION OF THE FIGURES

The invention will be described in greater detail below with reference to the attached figures, where

Fig. 1 shows a diagrammatic representation of a system for supply of
5 compressed gas,

Fig. 2 shows a diagrammatic representation of a method for establishing
whether or not a compressor in a system for supply of compressed
gas is operating or not,

10

Fig. 3 shows a diagrammatic representation of a system for cooling of
compressed air by fan control, where a system for supply of
compressed gas according to the invention is used,

15 Fig. 4 shows a diagrammatic representation of a method for establishing
cooling requirements, and

Fig. 5 shows a diagrammatic representation of an alternative method for
establishing cooling requirements.

20

ILLUSTRATIVE EMBODIMENTS

Figure 1 is a diagrammatic representation of a system for supply of
compressed gas. The system comprises a compressor 2 which is of a
25 conventional type and will therefore not be described in any more detail
here. The compressor 2 has an outlet port 3 to which a gas line 4 is coupled.
The compressed-air line connects said outlet port 3 to the inlet port 5 to one
or more pressure tanks 6. Between said outlet port of the compressor 2 and
the inlet port 5 of the pressure tank or pressure tanks 6 it is possible for one
30 or more active components to be connected, for example an air drier. The
system further comprises a first control member 7 which is arranged to

control the compressor 6 in a conventional manner. The first control unit is of a conventional type and will therefore not be described in any more detail here; it can, for example, be designed as is described in any of the following documents – Japanese Utility Model Public Disclosure No. 59-14891 (1984),

- 5 Japanese Patent Laid-Open No. 158392 (1984) or US Patent No. 4 863 355. As is indicated in Figure 1, the first control member can therefore be connected to a pressure sensor 8 arranged on said pressure tank or pressure tanks 6.
- 10 The first control member is thus arranged to adopt an active position when the compressor is controlled to operate whereby compressed gas is delivered to said pressure tanks, and a passive position when the compressor is controlled not to operate. The compressor 2 is thus designed on the one hand to operate in an active operational mode when the 15 compressor is supplying the compressed-air system with compressed air, and on the other hand to be disengaged or inactive when the compressor is not supplying the system. This can be achieved in a number of ways well known to the skilled person. According to one embodiment, a valve can be opened between cylinder spaces located in the compressor, the volumetric 20 efficiency of the compressor thus falling and the compressor in this state being unable to generate compressed air with a pressure exceeding the system pressure. According to a second embodiment, a valve connecting the cylinder spaces of the compressor to the surrounding atmosphere is opened. A third possibility is to drive the compressor via a disengageable 25 transmission.

The system further comprises a second control member 9 which is connected in signalling terms to a pressure sensor 10 arranged in the pressure tank or pressure tanks 6. The pressure sensor 10 can consist of 30 the pressure sensor which is used for the first control member or, alternatively, it can be a separate pressure sensor. In a preferred

embodiment, a separate pressure sensor is used, which increases the reliability of the verification of whether or not there are errors in the system.

The second control member 9 is arranged to establish that the compressor is
5 operating by means of the pressure recorded by the pressure sensor and the changes in pressure in the pressure tank, as will be described below.

The second control member, without actually generating control signals to the compressor, thus establishes that the latter is operating by virtue of a
10 pressure sensor 10, which is mounted in the pressure tank, recording the pressure and pressure changes in the pressure tank 6. This is achieved by the fact that the second control member 9 establishes that the compressor 2 is operating when said pressure sensor 10 records a pressure in the pressure tank 6 below a first limit value; that the second control member 9
15 establishes that the compressor is not operating when said pressure sensor 10 records a pressure in the pressure tank 6 above a second limit value, and that the second control member 9 establishes that the compressor 2 is operating when said pressure sensor 10 records a pressure in the pressure tank 6 between said first and second limit values and the sensor 10 records
20 that the pressure is rising, and that the second control member 9 establishes that the compressor 2 is not operating when said pressure sensor 10 records a pressure in the pressure tank 6 between said first and second limit values and the sensor records that the pressure is dropping or is constant.
According to one embodiment of the invention, the control member is also
25 arranged to establish that there is a risk of a function error if the pressure does not rise above a lower limit value and that an error exists if the pressure rises above an upper limit value.

Figure 2 is a diagrammatic representation of a method of determining
30 whether the compressor 2 is or is not driven in an active position when the compressor is feeding air to a pressure tank 6. A first step 40 determines

whether the pressure in the pressure tank is above a first limit value P_{\max} . If such is the case, the compressor is inactive. A second step 41 determines if the pressure is below a second limit value P_{\min} . If such is the case, the compressor is active. In a third step 42, it is noted if the pressure in the tank
5 is rising. If such is the case, the compressor is active. Otherwise, the compressor is inactive.

Figure 3 is a diagrammatic representation of a system for cooling of compressed air by means of fan control, with a system for supply of compressed gas according to the invention being used. The system
10 comprises a compressor 2 which is of a conventional type and will therefore not be described in any detail here. The compressor 2 has an outlet port 3 to which a compressed-air line 4 is coupled. The compressed-air line connects said outlet port to an inlet port 11 of a first active component 12. The first active component 12 preferably consists of an air drier. The air drier 12 also has a first outlet port 13 to which a second compressed-air line 14 is connected. The second compressed-air line 14 connects the air drier 12 to an inlet port 5 of a pressure tank 6. The pressure tank 6 thereafter supplies a set of air consumers (not shown). In an alternative embodiment, the first
15 active component consists of a circuit distribution valve, which divides the compressed-air system into two or more separate circuits. The system for supply of compressed air can also include more than one pressure tank. In the illustrative embodiment shown, the air drier 12 also has a second outlet port 15 which, via a third compressed-air line 16, is connected to the
20 disengagement mechanism of the compressor 2 and operates as a means of communicating a pneumatic signal to said disengagement mechanism.
25

The system for supply of compressed air also has a controllable fan 17. The fan is controlled by a control unit 18. The control of the fan 17 is such that
30 the fan 17 can at least be turned on and off, alternatively the control can be such that the speed of rotation of the fan can be controlled. According to one

embodiment of the invention, the fan 17 is driven by a speed-regulated electric motor, but it can also be mechanically coupled via a variable transmission to a motor of another type, for example a combustion engine 20. The variable transmission can be designed in a manner well known to 5 the skilled person; for example the speed of rotation can be controlled via a viscose clutch which connects a power outlet from the motor 20 to the axis of rotation of the fan 17.

In the illustrative embodiment shown, the fan 17 is a controllable fan which is 10 included in the cooling system of the combustion engine 20. The cooling system comprises a set of cooling channels (not shown) arranged inside the combustion engine, inlet and outlet channels 18 which lead the coolant fluid from the combustion engine 20 to a radiator 19. The cooling system also generally comprises a pump 21 mounted in an inlet channel. The fan 17 is 15 preferably mounted downstream of the cooler 19, which means that, if the system is mounted on a vehicle, the oncoming wind exerts a cooling effect on the radiator 19.

The compressed-air line 4, which connects the compressor 2 to the first 20 active component 12, is placed so that it extends past the stream of air generated by the fan 17, which means that the fan is able to cool the air compressed by the compressor and thus heated before it reaches the first active component 12. The compressed-air line 4 is preferably placed in such a way that it has a continuously falling path between the outlet port 3 of the 25 compressor and the inlet port 11 of the first active component. This means that there are no pockets in which water can gather, and in this way the formation of ice plugs is avoided in cold weather. Continuously falling path is intended to signify that, when mounted on a flat base, the perpendicular distance between the flat base and the line decreases along the path from 30 the outlet port 3 to the inlet port 11.

The control unit 18 is further arranged to establish cooling requirements for the compressed air delivered by the compressor 2 and to generate an activation signal for the controllable fan 17 when there is a cooling requirement, said first active component being protected from thermal
5 overload by compressed air fed from the compressor.

- The cooling requirement for the compressed-air line is calculated from information concerning the operational status of the compressor 2. This information includes information on whether the compressor is active or not,
10 active meaning that the compressor is supplying the compressed-air system with air. Information on the speed of rotation of the compressor is also used since the temperature of the compressed air rises with increased speed of rotation.
- 15 The compressor 2 is thus designed on the one hand to operate in an active operating mode in which the compressor supplies the compressed-air system with compressed air and on the other hand to be disengaged or inactive when the compressor is not supplying the system. This can be done in a number of ways well known to the skilled person. According to one
20 embodiment, a valve can be opened between cylinder spaces located in the compressor, in which case the volumetric efficiency of the compressor decreases and the compressor in this state is unable to generate compressed air with a pressure which is above the system pressure. According to a second embodiment, a valve connecting the cylinder spaces
25 of the compressor to the surrounding atmosphere is opened. A third possibility is to drive the compressor via a disengageable transmission.

The control unit 18 comprises a second control member 9 in accordance with what has been described above, which, without actually generating control
30 signals to the compressor, establishes that the latter is operating by means of a pressure sensor 10, which is mounted in the pressure tank 6, recording

- the pressure and the changes in pressure in the pressure tank 6. This is achieved by the fact that the control unit establishes that the compressor is operating when said pressure sensor records a pressure in the pressure tank below a first limit value; that the control unit establishes that the
5 compressor is not operating when said pressure sensor records a pressure in the pressure tank above a second limit value, and that the control unit establishes that the compressor is operating when said pressure sensor records a pressure in the pressure tank between said first and second limit values and the sensor records that the pressure is rising, and that the
10 control unit establishes that the compressor is not operating when said pressure sensor records a pressure in the pressure tank between said first and second limit values and the sensor records that the pressure is dropping or is constant.
- 15 Figure 4 is a diagrammatic representation of the steps which, according to one embodiment of the invention, are gone through in order to establish whether or not there is a cooling requirement. A first method step 30 establishes whether the compressor 2 is feeding air to the system or not. If the compressor is not operating, there is no cooling requirement. A second
20 step 31 determines whether the speed of rotation of the compressor exceeds a certain limit value. In one embodiment in which the compressor is driven by a combustion engine, the speed of rotation of the combustion engine is noted and cooling requirements may exist if the speed of rotation exceeds the idling speed of the combustion engine, which corresponds to a speed of
25 about 700 rpm. A third step 32 determines whether the external temperature exceeds a certain limit value. A cooling requirement exists only if the external temperature exceeds this limit value. According to one embodiment, this limit value is set at 0°C. A fourth step 33 determines whether a vehicle in which the compressed-air system is mounted is being driven forwards at a
30 speed in excess of a limit value. A cooling requirement exists only if the speed is below this limit value. According to one embodiment, the limit value

is set at 50 km/h. When the checks according to steps one through to four have been carried out and the responses have been in the affirmative, the control unit, in a fifth step 34, generates an activation signal for the electrically controlled fan.

5

Figure 5 shows an alternative embodiment for establishing whether or not there is a cooling requirement. A first method step 30 establishes whether the compressor 2 is feeding air to the system or not. This can be established by one of the methods indicated above. If the compressor is not operating,

10 there is no cooling requirement. A second step 31 determines whether the speed of rotation of the compressor exceeds a certain limit value. In one embodiment in which the compressor is driven by a combustion engine, the speed of rotation of the combustion engine is noted and cooling requirements may exist if the speed of rotation exceeds the idling speed of
15 the combustion engine, which corresponds to a speed of about 700 rpm. In a third step 35, the parameters of external temperature T and vehicle speed are used as input data for a control function for the parameters of speed and external temperature. Depending on the combination of these two values, an output signal is generated which indicates whether or not there is a cooling
20 requirement. In a fourth step 36, the control unit 18 generates an activation signal for the controllable fan if there is a cooling requirement.

The invention is not limited to the embodiments shown above and instead can be varied within the scope of the attached patent claims.

PATENT CLAIMS

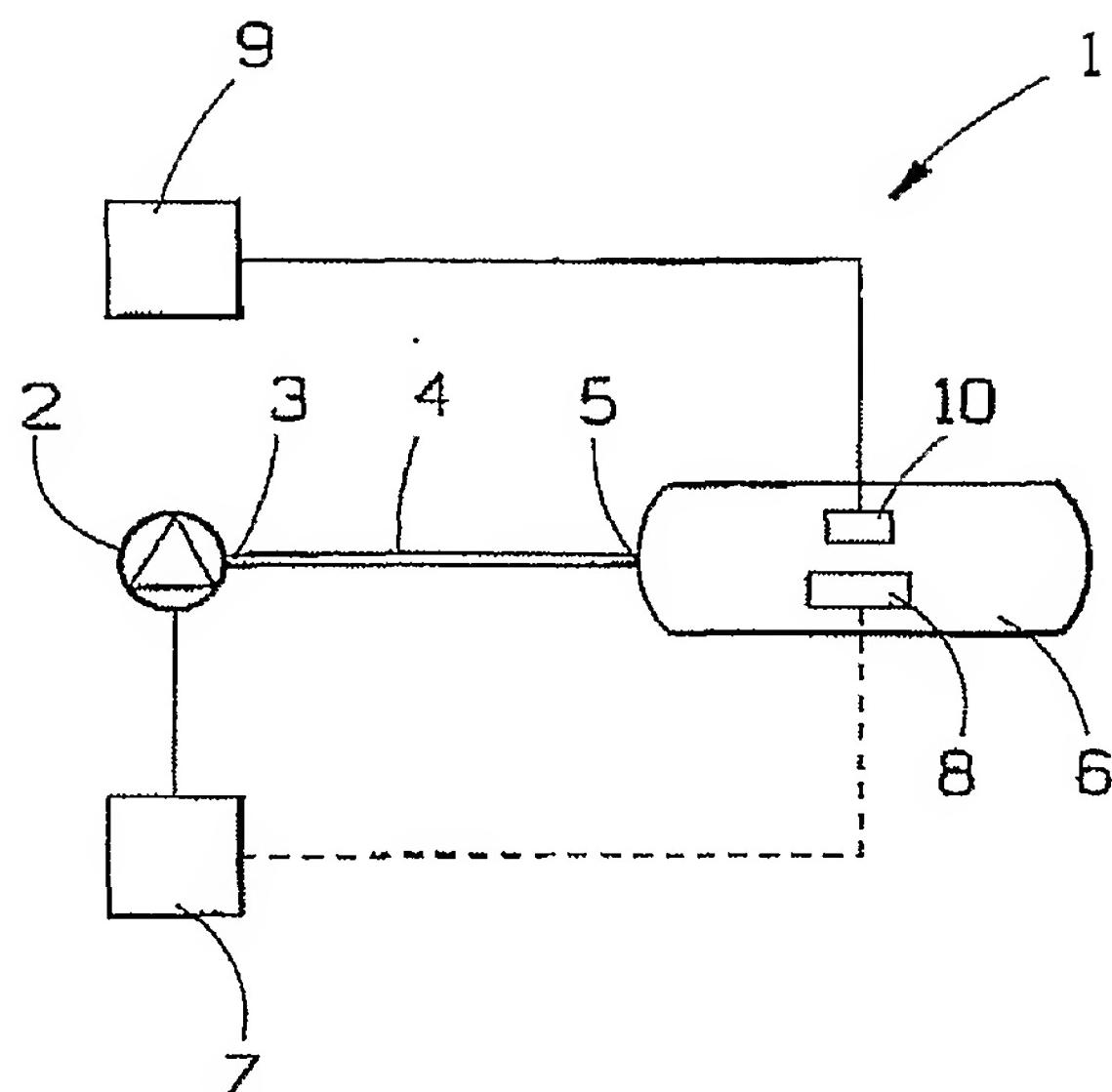
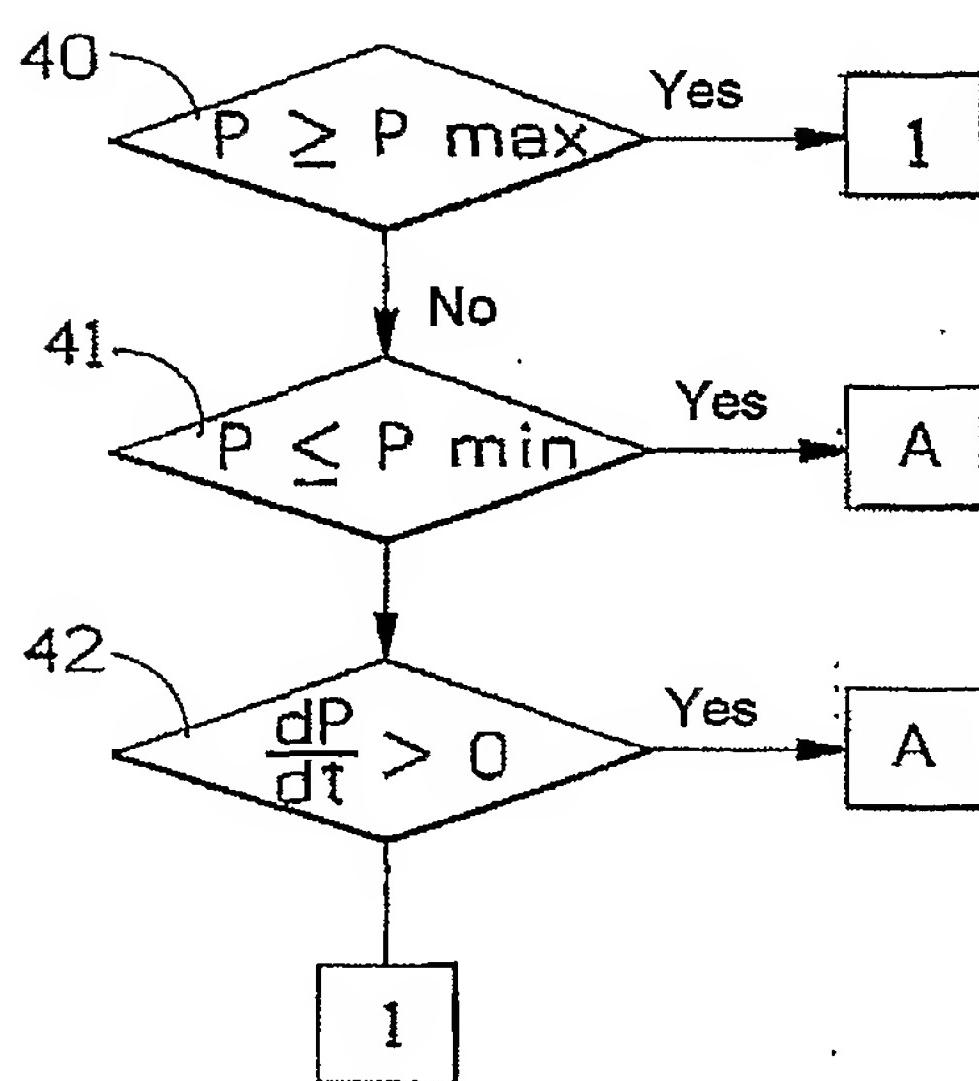
1. System for supply of compressed gas, comprising one or more pressure tanks (6), a compressor (2) which can be controlled via first control member (7) and is arranged to supply said pressure tank or pressure tanks (6) with compressed gas, where the first control member (7) is arranged to adopt an active state when the compressor (2) is controlled to operate whereby compressed gas is delivered to said pressure tank or pressure tanks (6), and a passive state when the compressor (2) is controlled not to operate, characterized in that the system comprises a second control member (9) which is connected in signalling terms to a pressure sensor (10) arranged in said pressure tank or pressure tanks (6), and in that the second control member (9) is arranged to establish that the compressor (2) is operating by analysis of the, by the pressure sensor (10), recorded pressure and pressure changes in the pressure tank or pressure tanks (6).
2. System for supply of compressed gas according to Patent Claim 1, characterized in that the second control member (9) is arranged to establish that the compressor (2) is operating when the pressure sensor (10) records a pressure below a first limit value.
3. System for supply of compressed gas according to Patent Claim 1 or 2, characterized in that the second control member (9) is arranged to establish that the compressor (2) is not operating when the pressure sensor (10) records a pressure above a second limit value.
4. System for supply of compressed gas according to Patent Claim 2 or 3, characterized in that the second control member (9) is arranged to establish that the compressor (2) is operating when said pressure

sensor (10) records a pressure between said first and second limit values and the sensor (10) records that the pressure is rising, and in that the second control member (9) is arranged to establish that the compressor (2) is not operating when the pressure sensor (10) 5 records a pressure between said first and second limit values and the sensor (10) records that the pressure is dropping or is constant.

5. Method for verifying whether a compressor (2) is operating in a system for supply of compressed gas comprising one or more pressure tanks (6), a compressor (2) which can be controlled via first control member (7) and is arranged to supply said pressure tank or pressure tanks (6) with compressed gas, where the first control member (7) is arranged to adopt an active state when the compressor (2) is controlled to operate whereby compressed gas is delivered to said pressure tank or pressure tanks (6), and a passive state when the compressor (2) is controlled not to operate, characterized in that 10 a second control member (9) which is connected in signalling terms to a pressure sensor (10) records the pressure and changes in pressure in the pressure tank or pressure tanks (6);
15 the second control member (9) establishing that the compressor (2) is operating when the pressure sensor (10) records a pressure below a first limit value,
the second control member (9) establishing that the compressor (2) is not operating when the pressure sensor (10) records a pressure 20 above a second limit value,
the second control member (9) establishing that the compressor (2) is operating when the pressure sensor (10) records a pressure between said first and second limit values and the sensor (10) records that the pressure is rising, and
25 the second control member (9) establishing that the compressor (2) is not operating when the pressure sensor (10) records a pressure 30

between said first and second limit values and the sensor (10) records that the pressure is dropping or is constant.

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FIG.1FIG.2

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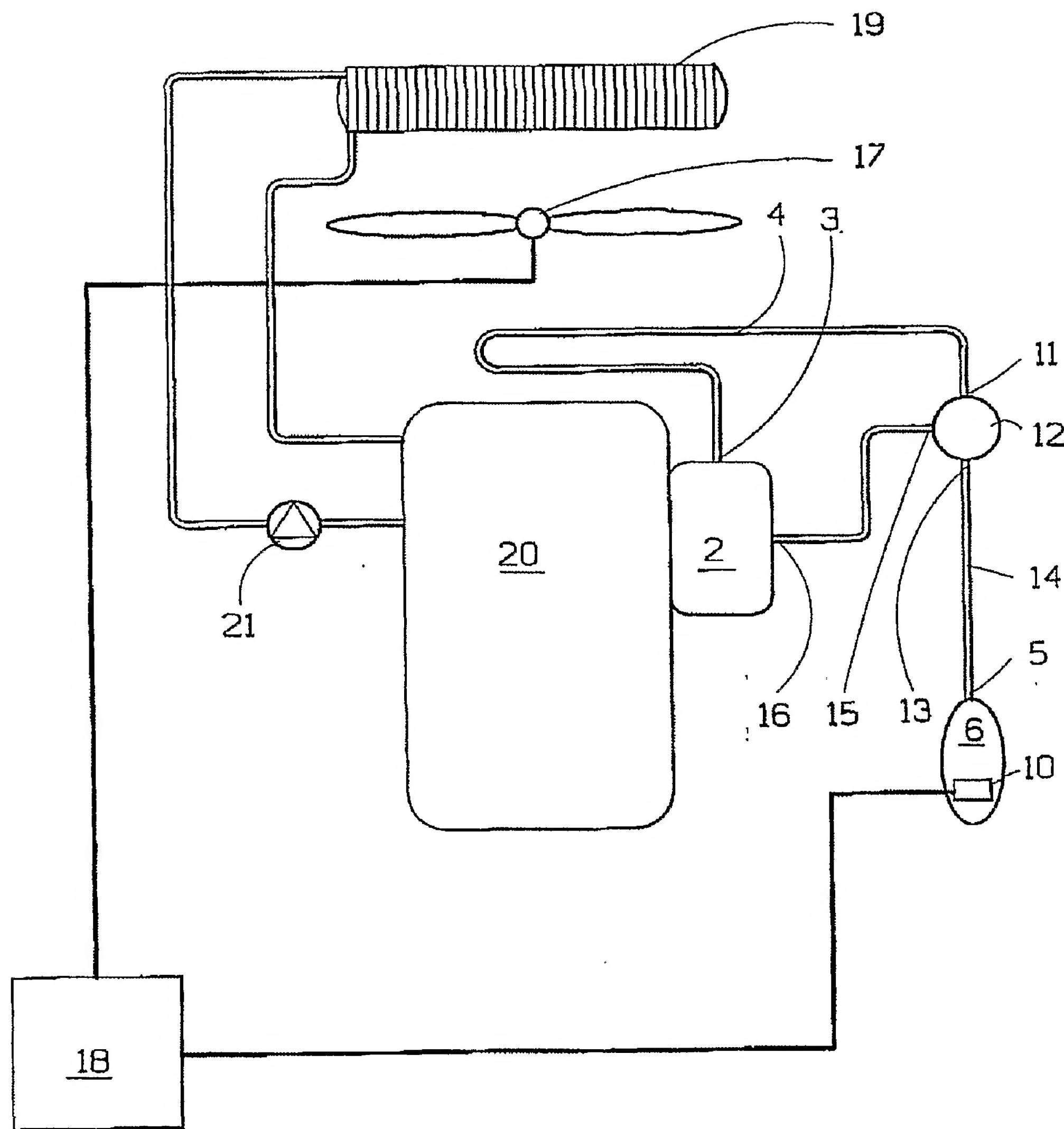
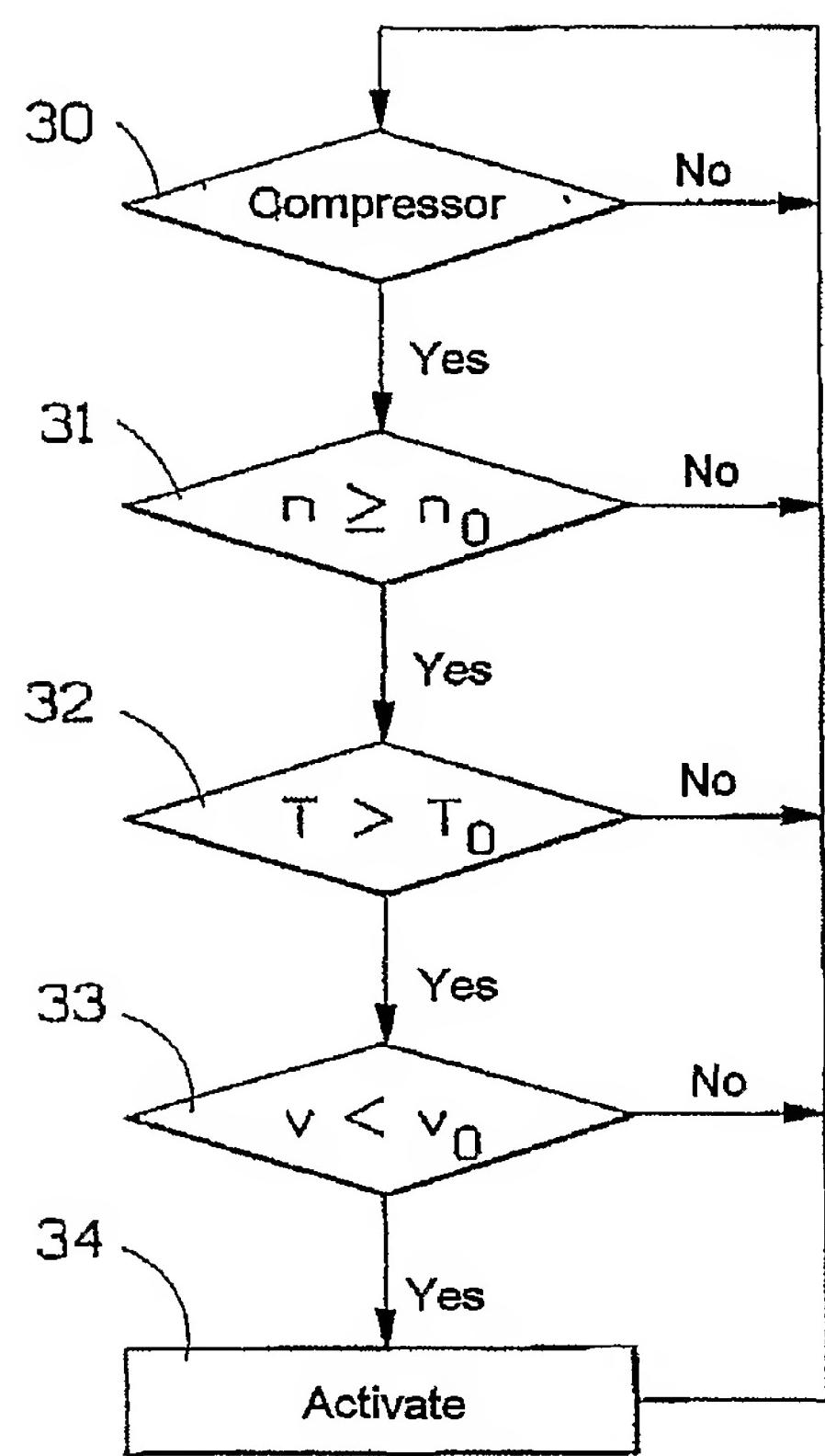
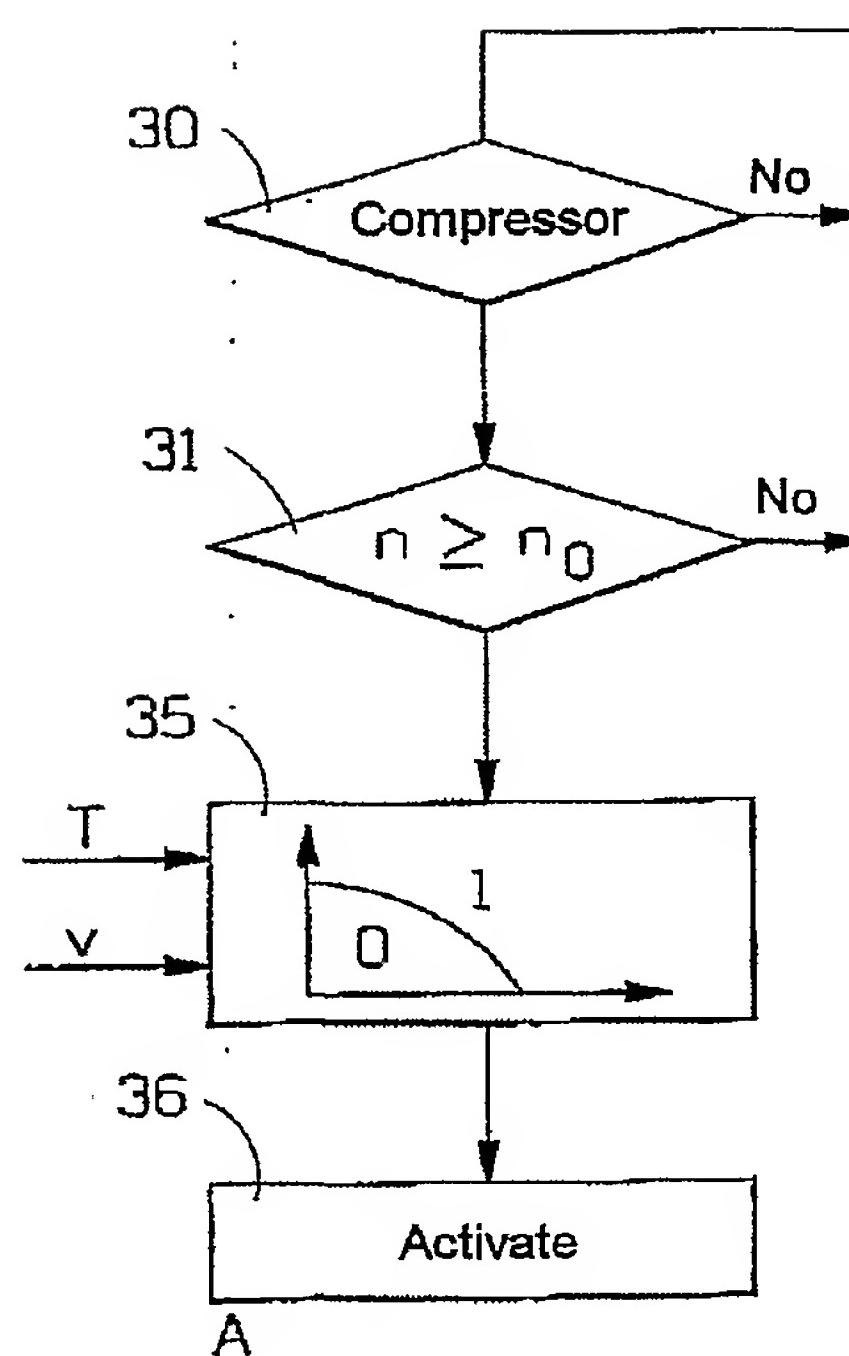


FIG.3

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FIG.4FIG.5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 02/01071

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: F04B 41/02 // F04B 4902, F04B 39/16, B60T 17/00
 According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: F04B, B60T

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL, WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0191150 A1 (KNORR-BREMSE AG), 20 August 1986 (20.08.86) --	
A	US 3860363 A (SILVERN ET AL), 14 January 1975 (14.01.75) --	
A	US 4863355 A (ODAGIRI ET AL), 5 Sept 1989 (05.09.89) --	
A	US 5592754 A (KRIEDER ET AL), 14 January 1997 (14.01.97) -----	

 Further documents are listed in the continuation of Box C. See patent family annex.

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Date of the actual completion of the international search
30 August 2002

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INTERNATIONAL SEARCH REPORT

Information on patent family members

06/07/02

International application No.

PCT/SE 02/01071

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
EP 0191150 A1	20/08/86	SE 0191150 T3 AT 37218 T CN 85108837 A,B DE 3445743 A DE 3564988 D HU 3098 A		15/09/88 09/07/86 19/06/86 00/00/00 29/10/86
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US 4863355 A	05/09/89	JP 1940922 C JP 6063504 B JP 63235677 A JP 63235678 A		23/06/95 22/08/94 30/09/88 30/09/88
US 5592754 A	14/01/97	NONE		